Nation for forms U.S. Department of Energy

Nuclear Energy University Programs

Fuel Cycle Technologies, Separations and Waste Forms Program

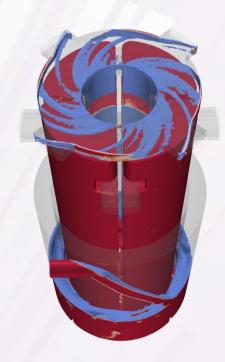
Terry Todd, National Technical Director

August 10, 2011



Separations and Waste Forms Mission

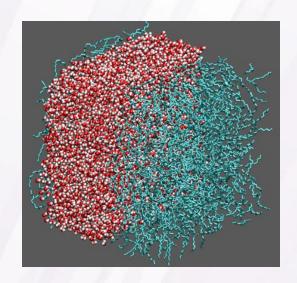
- Develop the next generation of fuel cycle separation and waste management technologies that enable a sustainable fuel cycle, with minimal processing, waste generation and potential for material diversion
 - Our job is to develop viable and economic technical options that will inform future decisions on the nuclear fuel cycle

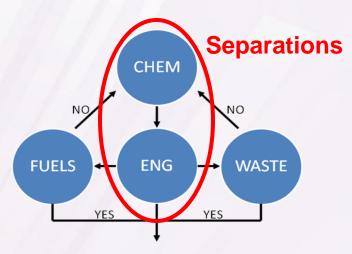




Fuel Cycle R&D

- The Separations R&D program is developing options to support possible future selection of sustainable fuel cycles
- A broad range of separation technologies are being investigated to support modified open and full recycle options
- The current separations program is also focused on understanding the scientific fundamentals of separation methods
- The separations program is closely linked to waste form R&D activities and interfaces regularly with fuels R&D to ensure coordination of approaches









Fuel Cycle Separations FY 2012 Focus Areas

Advanced Electrochemical **Technologies**

 U/TRU co-deposition, TRU and fission product drawdown, and metal/salt separations, on-line process monitoring and control

Advanced Aqueous Technologies

 On-line monitoring and transformational sampling approaches for aqueous processes, solvent degradation test loop,

Sigma Team for Minor **Actinide Separations**

 Simplified (one-step) An/Ln separations process, exploiting higher oxidation states of Am, chromatographic or alkaline-side separation. enhance the stability of dithiophosphinic extractants, utilize computational molecular design for new extraction ligands

Sigma Team for Off-gas Capture and **Immobilization**

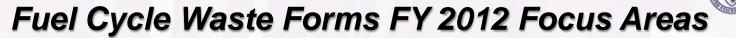
 lodine and krypton loading on solid zeolite sorbents, methods for tritium capture, alternative sorbents for iodine and krypton

Fundamental Science and Methods Development

 Thermodynamics and kinetics of extraction systems, radiation chemistry effects and mechanisms, non-ideality in liquid-liquid systems, solvent extraction data to support model development

Transformational Separations **Technologies**

 Regent modeling and design for development of new extractants, electrochemical separations in ionic liquids, advanced voloxidation methods; direct nitration, halide volatility processes





Alternative Waste Forms

• Alternative waste forms (e.g. ceramics, glass-ceramics, epsilon metal), and recycle of fuel components (Zr)

Waste From Characterization

Metal and oxide waste behavior over geologic time scales

Advanced Waste Form Processing

• Processing of alternative waste forms using advanced methods (e.g. cold crucible induction melting and spark plasma sintering)

Fundamental Waste Form Science

 Data for fundamental waste form models, effects of radionuclide decay on waste form solubility

Modeling and Simulation

 Waste form continuum model, pore diffusion model, first principle corrosion models



Separations and Waste Forms

Grand Challenges

- Simplified single-step separation process for americium or transuranic elements (TRU)
- Near-zero radioactive off-gas emissions (an order of magnitude lower than riskbased regulations)
- Reduce waste volume (generation) for high-level, low level, and greater than class C wastes, by an order of magnitude
- Increase durability of high-level and low level wastes by an order of magnitude over current reference (glass)



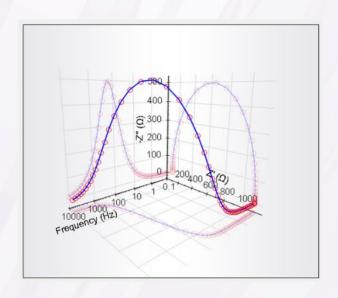


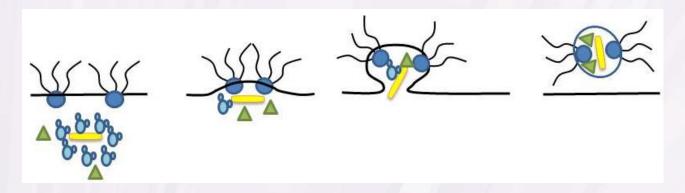
- Separations workshop was held July 27-28, 2011, in Washington DC on common areas of separations research across DOE programs (NE, NNSA, EM)
- Report anticipated by the end of August 2011 may identify new areas for R&D collaboration
 - Chemistry and Speciation of the Actinides and Key Fission Products (Cs, Tc, I)
 - Design of Molecules and Materials with Selective Separation Properties
 - Scale-up of Separation Processes from Bench-Top to Plant
 - Interface issues between Separations and Waste Forms/Fuel Fabrication

http://events.energetics.com/NuclearSeparationsTechnologyWorkshop/index.html



 Experimental collection of fundamental data to characterize and quantify chemical processes of aqueous or electrochemical separation, validation of modeling approaches as well as to develop a better understanding of separation methods

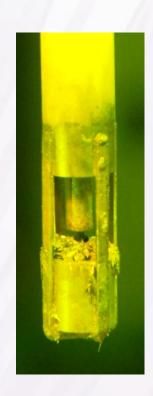






 Interfacial electrochemistry-Develop a fundamental understanding of interfacial electrochemistry of actinides and fission product elements important in the fuel treatment process

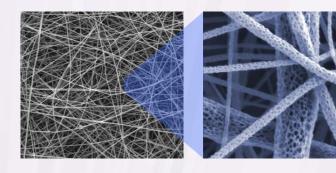


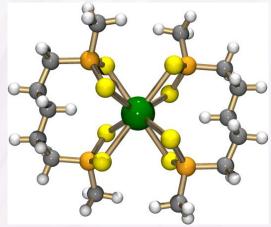




 Development of novel transformational separation technologies that have the potential of significantly reducing cost of processing fuel while reducing proliferation risk and waste generation









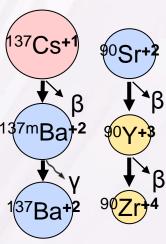


Development of alternative wasteforms that have the potential of significantly increased waste loading (of fission products) and durability over borosilicate glass











- Investigation of novel volatilization methods for complete or partial recycle of used fuel components
 - Approaches could include oxidation/reduction methods, reactive gas reagents, or any combination of approaches to segregate used fuel components for recycle or disposal



